Nuclear Energy Oversight Project, Inc.

"Oversight of the U.S. Nuclear Regulatory Commission to protect public health and safety and the environment"

9995 SE Federal Hwy. Unit 1763
Hobe Sound, Florida 33475
Email: NEOP@gmx.com
Phone: (772) 206-2489

Thomas Saporito
Executive Director

January 22, 2021

Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
(Sent via Electronic Mail)

RE: JANUARY 22, 2021 SUPPLEMENT TO 10 CFR 2.206 PETITIONS DATED OCTOBER 31, 2020 AND NOVEMBER 6, 2020 (CHARPY TESTING)

The Nuclear Energy Oversight Project (NEOP) - by and through its undersigned Executive Director (Petitioners) - hereby submit a Supplement to 10 CFR 2.206 petitions dated October 31, 2020 and November 6, 2020 and request that the U.S. Nuclear Regulatory Commission (NRC) take enforcement action against all NRC Pressurized Nuclear Reactor Operators (licensees) as delineated below:

Requested Enforcement Action

Petitioners request that the NRC:

- Issue a Confirmatory Order (CO) requiring the licensees to state and affirm under oath how the general public could realistically evacuate during a declared General Emergency - Loss of Coolant Accident (LOCA) - stemming from a fractured nuclear reactor vessel and melted reactor core - as a direct or indirect result of a pressurized thermal shock (PTS) event - or from degradation and damage of the nuclear reactor vessel from the effects on neutron fluence; and

- Issue a CO requiring the licensees to perform a one-time inspection of the continuous circumferential transition cone closure weld on each steam generator (essential 100 percent examination coverage of each weld) employing non-destructive radiographic testing; and

- Issue a CO requiring the licensees to perform a one-time inspection of the reactor vessel (RV) extended beltline region of the RV shell material, including welds, heat-

affected zones, and plate or forgings adjacent to the beltline region employing non-destructive radiographic testing; and

- Issue a CO requiring the licensees to modify and reduce each nuclear reactor's pressure-temperature limits within the licensees' respective plant technical specifications to limit full-power operation of their nuclear reactors to no more than 80% (to limit the amount of reactor vessel damage) due to neutron fluence during the period of extended operations.

- Issue a CO to licensees that submit Charpy testing data to the NRC obtained from another nuclear reactor vessel surveillance capsule as part of the NRC participant program, as representative of data showing the degree of neutron fluence damage (embrittlement) to the licensee's plant-specific RV, to affirm under oath that the capsule data fully complies with Section I.3 Limitations, Subsections 1-3 of the NRC Regulatory Guide dated May 1988, Revision 2, accordingly.

Basis and Justification

In a 10 CFR 2.206 petition dated October 31, 2020, Petitioners contended that:

- The current methodology used by NRC licensees to determine the degree of embrittlement of pressurized nuclear reactor vessels is not sufficient to protect the health and safety of the public and the environment; and

- The current licensee participant program utilized by NRC licensees in sharing pressurized nuclear reactor vessel capsule sample data does not provide sufficient and reliable data to determine the degree of embrittlement of the licensees' pressurized nuclear reactor vessel; and

- The current pressurized nuclear reactor vessel surveillance programs utilized by NRC licensees does not provide sufficient and reliable data to the NRC in determining the degree of embrittlement of the licensees' pressurized nuclear reactor vessel; and

- The PWROG-18068 use of direct fracture toughness for evaluation of RPV integrity is a more accurate methodology to determine the degradation and degree of embrittlement of a pressurized nuclear reactor vessel

In a 10 CFR 2.206 petition dated November 8, 2020, Petitioners averred that:

- The NRC cannot accept or rely on the data provided by the licensee regarding the reactor vessel capsule Y analysis report (WCAP-18558-NP) because the licensee failed to identify the model number of the Instron Impulse system which the Charpy machine striker was instrumented with; and

- The NRC cannot accept or rely on the data provided by the licensee regarding the reactor vessel capsule Y analysis report (WCAP-18558-NP) because the licensee obtained data on the Beaver Valley Power Station, Unit No. 2 (BVPS-2) reactor vessel

capsule Y using an outdated Charpy test machine which is apparently no longer manufactured - and has been since replaced by the vendor with more accurate Charpy test machines which do not involve interpretation of an analog gauge by a human - and which newer machines employ a digital display that can be directly linked to a PC and connected to Tinius Olsen's Horizon software.

On December 21, 2020, the NRC-PRB provided an initial assessment of the October 31, 2020 and November 8, 2020 petitions. With respect to the October 31, 2020 petition, the NRC-PRB stated in part that:

- Instrumented Charpy testing is not necessary to demonstrate compliance with the regulations, or to assess embrittlement of the RPV consistent with guidance in Regulatory Guide 1099, "Radiation embrittlement of Reactor Vessel Materials," Revision 2 (ADAMS Accession No. ML031430205).

- The NRC staff reviews and approves the use of integrated surveillance programs in-lieu of a plant-specific surveillance program. . .and ensures that the representative materials chosen for surveillance for an RPV are irradiated in one or more other reactors that have similar design and operating features to permit accurate comparisons of the predicted amount of radiation damage. . . Other factors, such as transient behavior during reactor trips raised in the petition, have no discernible impact on the ability of surveillance specimens from one plant to provide relevant data to assess radiation embrittlement of another plant, since the elastic deformation of the RPV steel due to such evolutions does not affect the degree of the embrittlement.

- Since RPV fluence calculations explicitly consider the actual plant operating history, the additional neutron fluence from a power uprate or license renewal is incorporated in the plant-specific calculations.

- With respect to direct fracture toughness measurements as referenced in PWROG-18068, the NRC-PRB stated that, The addition of these requirements would not have a corresponding benefit to public health and safety.

With respect to the November 8, 2020 petition, the NRC-PRB stated in part that:

- The use of manual reading of data provides sufficiently accurate readings of the absorbed energy to fracture the surveillance specimens, consistent with the pertinent consensus codes and standards, to adequately assess the condition of the RPV.

- The use of instrumented Charpy testing apparatuses are capable of providing the data necessary to adequately assess RPV embrittlement; however, the mandatory use of these apparatuses is beyond the current regulations.

- Given that the NRC's regulatory framework relies on consensus codes and standards. . . it is not necessary for the staff to require the use of the most up-to-date apparatus to perform instrumented Charpy testing.

On this date, January 22, 2021, Petitioners state in further support of the requested NRC enforcement actions that:

- The NRC Petition Review Board's (PRB's) initial response dated December 21, 2020, to the aforementioned petitions, appears to be (1) a fraud on the American people with respect to the NRC's acceptance of the licensees' submittal of data purported to represent the degree of embrittlement of PRV's due to damage caused by neutron fluence; and (2) a waste of American taxpayer funds appropriated by the United States Congress to the NRC with respect to the expenditure of NRC resources in "rubber stamping" license extensions of nuclear reactors up to 80-years and 40-years beyond their original "safety design" basis and apparently in collusion with its licensees, to continue the operation of the NRC and its federal employees as an ongoing federal agency to regulate the nuclear power industry; and (3) a gross abuse of authority and power by the NRC in granting license extensions up to 80-years in direct violation of the NRC's Congressional mandate to protect the health and safety of the public and to protect the environment from the catastrophic effects from a serious nuclear Loss of Coolant Accident (LOCA) caused by a cracked reactor vessel damaged and embrittled by neutron fluence during extended power operations beyond the reactor vessel's original 40-year safety design basis.

United States Government Agencies Have Colluded With Private Sector Industries in the Past and Have Mislead the Public Regarding Safety Which Resulted in Deaths

The U.S. Federal Aviation Administration Colluded With Boeing

On September 16, 2020, the Chair of the House Committee on Transportation and Infrastructure Peter DeFazio (D-OR) and Chair of the Subcommittee on Aviation Rick Larsen (D-WA) released the Committee's final report on the Boeing 737 MAX. This report, prepared by Majority Staff, lays out the serious flaws and missteps in the design, development, and certification of the aircraft, which entered commercial service in 2017 before suffering two deadly crashes within five months of each other that killed a total of 346 people, including eight Americans. The Committee's 238-page report, which points to repeated and serious failures by both The Boeing Company (Boeing) and the Federal Aviation Administration (FAA), contains five central themes and includes more than six dozen investigative findings. These themes include:

Production pressures that jeopardized the safety of the flying public. There was tremendous financial pressure on Boeing and the 737 MAX program to compete with Airbus' new A320neo aircraft. Among other things, this pressure resulted in extensive efforts to cut costs, maintain the 737 MAX program schedule, and avoid slowing the 737 MAX production line.

Faulty Design and Performance Assumptions. Boeing made fundamentally faulty assumptions about critical technologies on the 737 MAX, most notably with MCAS, the software designed to automatically push the airplane's nose down in certain conditions. Boeing also expected that pilots, who were largely unaware that MCAS existed, would be able to mitigate any potential malfunction.

Culture of Concealment. Boeing withheld crucial information from the FAA, its customers, and 737 MAX pilots, including internal test data that revealed it took a Boeing test pilot more than 10 seconds to diagnose and respond to uncommanded MCAS activation in a flight simulator, a condition the pilot described as “catastrophic.” Federal guidelines assume pilots will respond to this condition within four seconds.

The National Highway Traffic Safety Administration Colluded With the Auto Industry

On June 2, 2005, The National Highway Traffic Safety Administration (NHTSA) estimates that airbags installed in automobiles have saved some 10,000 lives as of January 2004. A just-released study by a statistician at the University of Georgia, however, casts doubt on that assertion. In fact, said UGA statistics professor Mary C. Meyer, a new analysis of existing data indicates that, controlling for other factors, airbags are actually associated with slightly increased probability of death in accidents. NHTSA recorded 238 deaths due to airbags between 1990 and 2002, according to information about these deaths on their Web site,” said Meyer. “They all occurred at very low speeds, with injuries that could not have been caused by anything else. But is it reasonable to conclude that airbags cause death only at very low speeds? It seems more likely that they also cause deaths at high speeds, but these are attributed to the crash.

The National Highway Traffic Safety Administration (NHTSA) estimates that airbags installed in automobiles have saved some 10,000 lives as of January 2004. A just-released study by a statistician at the University of Georgia, however, casts doubt on that assertion. In fact, said UGA statistics professor Mary C. Meyer, a new analysis of existing data indicates that, controlling for other factors, airbags are actually associated with slightly increased probability of death in accidents. NHTSA recorded 238 deaths due to airbags between 1990 and 2002, according to information about these deaths on their Web site,” said Meyer. “They all occurred at very low speeds, with injuries that could not have been caused by anything else. But is it reasonable to conclude that airbags cause death only at very low speeds? It seems more likely that they also cause deaths at high speeds, but these are attributed to the crash.

“When we look at the random sample of all accidents, we find that airbags are associated with increased risk of death,” she said, “and this increase is due to more deaths with airbags in low-speed crashes and no seat belts. However, if we limit the data set to include only collisions in which a fatality occurred, we get a significantly reduced risk of death due to airbags.” By way of analogy, the Meyer explained it this way: “If you look at people who have some types of cancer, you will see that those who get radiation treatment have a better chance of surviving than those who don’t. However, radiation is inherently dangerous and could actually cause cancer. If you give everyone radiation treatments, whether they have cancer or not, you will probably find an increased risk of death in the general population. “Making everyone have airbags and then verifying the effectiveness using only fatal crashes in FARS is like making everyone get radiation and then estimating the lives saved by looking only at people who have cancer. Overall, there will be more deaths if everyone is given radiation, but in the cancer subset, radiation will be effective.” The new study directly contradicts assertions about airbag safety on the NHTSA Web site, said Meyer. The correct analysis is important to obtain now, because in only a few years, there will be virtually no cars

on the road without airbags. “We are confident that our analysis better reflect the actual effectiveness of airbags in the general population [than earlier studies],” said Meyer. “The evidence shows that airbags do more harm than good.”

The U.S. Atomic Energy Commission Colluded With the General Electric Company and the Nuclear Industry

In a March 26, 2013, publication Arnie Gundersen a former nuclear engineer stated that:

Dismissing pleas from citizen groups in local U.S. communities where General Electric’s Fukushima-style reactors operate and ignoring expert testimony from independent nuclear engineers, the NRC voted earlier this month against a plan to require utility owners to upgrade nuclear plant filtering systems with vents — “radiation scrubbers” — intended to reduce (not eliminate) radiation levels when the vents are opened in a severe accident. The nuclear industry’s Congressional allies fought the proposal — “Safety gains should be significant enough to outweigh additional costs” to be paid by industry, said Representative John Shimkus (IL), chairman of an Energy and Commerce subcommittee — while Sen. Barbara Boxer (CA), in a letter sent to the NRC last month, wrote, “The tens of millions of Americans who live near the affected reactors located in 15 states should not face additional delays.”

“This is not just a Fukushima-Daiichi issue–the issues in the United States are in some ways much worse,” warned Arnie Gundersen, a week before the vote was taken, in the kick-off presentation at a symposium on the Fukushima disaster held in mid-March at the New York Academy of Sciences in New York City. It was sponsored by the Helen Caldicott Foundation and Physicians for Social Responsibility. Gundersen is a former nuclear industry engineer turned whistleblower, and his ongoing reports over the last two years on the Fukushima disaster in Japan (here) repeatedly raise warnings about the GE reactors and their vulnerability to accidents. The main difference between US and Japanese GE plants is the extreme amount of highly radioactive spent fuel stored in reactor spent fuel pools, which are located five stories above the reactors. The U.S. spent fuel pools in GE’s Fukushima-style reactors *each* contain more irradiated fuel than the total in all four reactor pools at the Fukushima plant.

Following the initial news reports of explosions at the Fukushima plant inside the GE reactor containment buildings, stories quickly appeared reporting that federal nuclear safety regulators who licensed the reactors knew about their design flaws but did not to stop GE from selling them. “Scientists in the United States recognized in 1965 that this Mark 1 had design flaws,” Gundersen said. But GE threatened to pull out of the commercial reactor business if forced to make costly design changes. Gundersen recalled a comment by Glenn Seaborg, chairman of the Atomic Energy Commission from 1961 to 1971, who said in an interview years later: “I didn’t think we had the power to stop them.” “Think about that,” said Gundersen. “This is the United States government and it didn’t have the power to stop General Electric’s faulty design in 1966.”

At the time both GE and Westinghouse were in fierce competition for top place in the new commercial reactor industry. GE was willing to take a loss on sales of its Mark 1 Boiling Water Reactor — and it did. “GE lost millions,” Gundersen said. (“Our people understood this was a game of massive stakes and that if we didn’t force the utility industry to put these stations on line, we’d end up with nothing,” a GE VP told Fortune Magazine in an interview in 1970.) AEC documents reveal that federal safety experts recommended banning the Mark 1’s pressure suppression containment system and cited its vulnerability to an explosion that would follow a loss-of-coolant accident. The concerns were dismissed by Joseph Hendrie, then the AEC’s top safety regulator who was later appointed NRC chairman. In a 1972 memo, Hendrie thought such an action “could well be the end of nuclear power,” and would “create more turmoil than I can stand thinking about.” “So the turmoil that Hendrie chose to avoid in 1972 became the turmoil that Japan suffered 40 years later,” Gundersen said.

NRC Amends the Reactor Vessel Material Surveillance Program Requirements for Commercial Light Water Reactors

On December 29, 2020, the NRC finalized and amended the reactor vessel material surveillance program requirements for commercial light water reactors. See, Federal Register Volume 85, Issue 249. In so doing, the NRC appears to have significantly increased the risk to public heath and safety by (1) eliminating the testing of certain specimen materials inside capsules placed within pressurized nuclear reactor vessels by licensees; and (2) by extending the reporting time requirements for the test results of the specimen material of the capsules by licensees; and (3) by eliminating the requirement for licensees to include or test heat-affected zone specimens as part of the reactor vessel material surveillance program; and (4) by revising appendix H to 10 CFR part 50 to make optional the requirement to include or evaluate temperature monitors as part of the reactor vessel material surveillance program.

Petitioners note here that the NRC's new rules apply to extended operation of pressurized nuclear reactors for up to 80-years and that the NRC is actively working with the nuclear industry to extend operations to 100-years.

Petitioners challenged these rule changes by submitting comments to the NRC via the NRC website for such public participation. However, the NRC never contacted Petitioners regarding their opposition views, but instead, simply ignored Petitioners safety concerns related to the NRC's rule changes, and adopted the changes none-the-less.

Petitioners aver here that the NRC acting in concert with the nuclear industry finalized the reactor vessel material surveillance program requirements for pressurized nuclear reactor vessels to (1) allow the nuclear industry to continue to operate old nuclear reactors which were originally constructed with only a 40-year safety design basis; and (2) to protect and ensure numerous NRC jobs that depend on the nuclear industry’s continued operation of old pressurized nuclear reactors. Petitioners contend that the NRC's actions in finalizing the new rules for the reactor vessel material surveillance program requirements jeopardize public health and safety and that the NRC appears to have colluded with the nuclear industry for the economic benefit of its licensees and for the longevity benefit of NRC jobs and the NRC's existence as a federal agency.

To the extent that the NRC appears to have engaged in misconduct in violation of its own policies and mission statement and Congressional mandate as described immediately above, Petitioners request that the NRC-PRB provide the NRC Office of the Inspector General (OIG) with a copy of the record transcripts of this teleconference call and any and all other documents, notes, emails, and other communications and correspondence by the NRC related to this matter, in accordance with NRC policy at MD 7.4, "Reporting Suspected Wrongdoing and Processing OIG referrals." See, Appendix B - Guide for Processing 10 CFR 2.206 Petition at p.1, Section I.B.3.

Petitioners note here for the public record, that the NRC-OIG has opened an allegation under (A 21 08848) with respect to the subject matter of 2.206 PRV Embrittlement issue. Therefore, any assistance on the part of the NRC in assisting the OIG in its open investigation in this matter will serve to further protect the health and safety of the public and to protect the environment and is appreciated.

Clarification and Further Basis and Justification

As a threshold matter, the Atomic Energy Act of 1954 (AEA), as amended, authorizes the NRC to issue operating licenses to nuclear plant operators and also authorizes renewal of expired operating licenses and states in relevant part that: ". . . Each such license shall be issued for a specified period, as determined by the Commission, depending on the type of activity to be licensed, but not exceeding forty years from the authorization to commence operations, and may be renewed upon the expiration of such period. . . " See, 42 U.S.C. §2133(c).

Petitioners contend here that the NRC appears to have violated the AEA in renewing operating licenses for extended power operations of its licensees before the expiration of the prior period. To the extent that the NRC's actions in granting its licensees extended power operational licenses before the expiration of the prior period, the extended power operational licenses are NOT valid. Therefore, Petitioners request that the NRC issue a CO requiring all licensees who were granted extended power operational licenses by the NRC before the expiration of the prior period, to immediately shut down their respective nuclear reactors.

Common sense shows that NRC regulations relied upon by NRC licensees such as the Florida Power and Light Company (FPL), in the early 1970's who were granted operating licenses for the Turkey Point Nuclear Plant (TPN) Units 3 and 4, employed highly qualified degreed nuclear engineers who complied with the NRC regulatory guides at that time with respect to estimating or guesstimating the expected amount of damage to the Reactor Vessel (RV) due to neutron fluence for the original 40-year safety design basis of the RV. Subsequently, NRC nuclear engineers reviewed FPL's license amendment requests and estimated neutron fluence damage to the the RV (embrittlement), and issued two operating licensees for a 40-year period of operation. As the years passed, the American people through innovation discovered and developed other means to generate electric power and generally opposed nuclear power generation. Petitioners aver here that the NRC and the nuclear industry feared the end of nuclear power in the United States was at hand and therefore NRC in concert with the nuclear industry, made a decision to grant operating license extensions up to 80-years and 40-years beyond the original safety design basis for nuclear

reactors.

To the extent that both the licensee's nuclear engineers and those of the NRC who originally justified operation of PRVs for only 40-years due to concerns over the degree of embrittlement of the RV from neutron fluence, can now somehow contend via estimates and guesstimates using vague formulas with assumptions about the amount of error in the calculations of neutron fluence in the NRC regulations, strains all reasonable thinking. Rather, it appears that the NRC in concert with the nuclear industry are working together to extend the operation of PRVs up to 80-years and possibly 100-years in the United States at the expense of public health and safety! This becomes even more evident in reviewing the numerous licensee applications for extended operations where it appears that the NRC accepts a "cookie-cutter" generic type of application requiring both PRVs and BWRs to respond to various technical questions using the very same application, instead of the NRC having two separate applications. To the extent that the NRC and its licensees can somehow look an additional 40-years into the future and issue an Environmental Impact Statement, as part of a licensee's application for extended power operations, is well beyond belief and absolutely not realistic. It appears to be fraud.

Petitioners further contend here that licensed operations of a PRV within 200-miles or less of Washington, D.C. in extended power operations beyond the PRV's original 40-year safety design basis, represents an unwarranted and unacceptable risk to the National Security and Common Defense of the United States of America. For this reason standing alone, the NRC should issue a CO requiring licensees of such located PRVs to immediately shut down.

- Licensee emergency plans are not sufficient to protect the health and safety of the public during a declared General Emergency - due to a Loss of Coolant Accident (LOCA) stemming from a fractured nuclear reactor vessel and resulting reactor core melt down, caused by a damaged RV from the effects of neutron fluence which caused the RV to fracture during a reactor trip and subsequent PTS event. Indeed, the Fukushima nuclear disaster and reactor core melt downs resulted in mass evacuations and the U.S. NRC recommended that the public in Japan be evacuated in a 100-mile radius of the damaged nuclear reactors, and not the 50-mile radius currently embraced in licensee evacuation plans in the United States.

- The NRC must require licensees to perform a one-time inspection of the continuous circumferential transition cone closure weld on each steam generator (essential 100 percent examination coverage of each weld) employing radiographic testing is required to protect the health and safety of the public during a 60-year or 80-year period extended power operations of PRVs. The failure of this weld would absolutely result in a major nuclear LOCA which would kill and harm millions of Americans in the United States. Radiographic testing is the ONLY reliable method of testing and examination to ensure that no cracks or voids exist in the weld. Radiographic testing (1) provides an extremely accurate permanent record; and (2) is very sensitive and can expose cracks and voids where other testing methods cannot. Therefore it is imperative that licensees perform radiographic testing on these areas of their respective RVs to protect the health and safety of the public during extended power operations. The failure of

licensees to conduct such radiographic testing is not a sufficient reason to justify extended power operations for 60 years or 80 years, because Charpy testing of RV capsule materials is not sufficient nor reliable in determining the degree of neutron damage to the RV over a 60-year or 80-year period of extended power operations.

- The NRC must require licensees to perform a one-time inspection of the reactor vessel (RV) extended beltline region of the RV shell material, including welds, heat-affected, and plate or forgings adjacent to the beltline region employing non-destructive radiographic testing. The failure of this weld would absolutely result in a major nuclear LOCA which would kill and harm millions of Americans in the United States. Radiographic testing is the ONLY reliable method of testing and examination to ensure that no cracks or voids exist in the weld. Therefore it is imperative that licensees perform radiographic testing on these areas of their respective RVs to protect the health and safety of the public. The failure of licensees to conduct such testing is not sufficient reason to justify extended power operations for 60 years or 80 years, because Charpy testing of RV capsule materials is not sufficient nor reliable in determining the degree of neutron damage to the RV over a 60-year or 80-year period of extended power operations.

Moreover, NRC Regulatory Guide 1.99, Revision 2, May 1988, at paragraph B.3 states that:

> ". . .The definition of reactor vessel beltline given in Paragraph II.F of the Appendix G requires identification of region of the reactor vessel that are predicted to experience sufficient neutron radiation embrittlement to be considered in the selection of the most limiting material. Paragraphs III.A and IV.A.1 specify the additional test requirements for beltline materials that supplement the requirements for reactor vessel materials generally. . . "

Thus, it is imperative that licensees perform a one-time inspection of the reactor vessel (RV) extended beltline region of the RV shell material, including welds, heat-affected, and plate or forgings adjacent to the beltline region employing non-destructive radiographic testing.

- In addition, a modification to each licensee's nuclear reactor's pressure-temperature limits within the licensee's respective plant technical specifications to limit full-power operation of their nuclear reactors to no more than 80% is required to limit the amount of reactor vessel damage due to neutron fluence during the period of extended operations. This is true because both the licensees and the NRC are simply guessing about the amount of damage (embrittlement) to the RV will be sustained due to neutron fluence during the period of extended power operations. Thus, the described operational modifications will serve to protect the health and safety of the public.

One characteristic of reactor vessel steels is that their material properties change as a function of temperature and neutron irradiation. The primary property of interest for the purposes of reactor vessel integrity is the fracture toughness of the reactor vessel material. Extensive experimental work determined that Charpy impact energy tests, which measure the

amount of energy required to fail a small material specimen, can be correlated to changes in fracture toughness of a material. Thus, the Charpy impact specimens from the beltline materials (i.e., base metal, weld metal, and heat-affected zone) became the standard to assess the change in fracture toughness in ferric steels. the fracture toughness of reactor vessel materials decreases with decreasing temperature and with increasing irradiation from the reactor. See, Federal Register Volume 85, Number 192 (Friday, October 2, 2020).

Petitioners aver here that while Charpy impact testing was used on PRVs capsule samples for up to a 40-year period of operation, Charpy impact testing is not sufficient to ascertain the amount of damage (embrittlement) sustained by a PRV from neutron fluence over a 60-year or 80-year or 100-year period of extended power operations. The Army Materialsand Mechanics Research Center, AMMRC, managed a program for many years on the certification of Charpy impact machines. What is evident is that each model machine possesses its own characteristic weaknesses which, unless controlled, can easily result in erroneously high test values. It is estimated that approximately half of the machines in use today are producing values well in excess of the limits set in Army specifications; that is, plus or minus 5 percent or 1.0 ft-lb, whichever is greater. Since most discrepancies either slow down the pendulum or result in absorptional losses, the value recorded includes energy not expended in fracturing the specimen, thus creating a false sense of security for the investigator or design engineer. See, N. Fahey, "The Charpy Impact Test - Its Accuracy and Factors Affecting Test Results," in Impact Testing of Metals, ed. D. Driscoll (West Conshohocken, PA: ASTM International, 1970), 76-92.

Petitioners further aver that, while Charpy impact tests are useful in the analysis and prediction of the behaviors of different materials under impact stresses or dynamic loading, such tests cannot directly predict the reaction of a material to real life loading. Instead, the results can only be used for comparison purposes. Like hardness tests, impact tests do not result in a number that definitively describes the material's toughness. Instead, impact tests yield comparative data, which is interpreted in combination with an analysis of the broken surfaces of the test specimens themselves. The performance of a specimen in a Charpy impact test is, however, influenced by many factors beyond material composition and temperature such as yield strength and ductility, placement, size, and shape of notches, strain rate, and fracture mechanism all affect the performance of a sample. . . When as many of the factors are held constant as possible, the results of an impact test reflect the toughness of the material, although even then the values found are useful only to compare to other results, and not as a simply defined property that can be stated universally as a single value. See, E59 Laboratory Report - Submitted October 21, 2008, Department of Engineering, Swarthmore College.

Moreover, dynamic tests such as the Charpy impact test yield information regarding the energy absorbed in breaking the test piece. This approach is useful in comparing materials but gives virtually no information regarding intrinsic properties of the material such as fracture toughness. See, January 14, 1977, Department of Defense, Australian Defense Scientific Service Materials Research Laboratories, Maribyrnong, Victoria.

Thus, petitioners aver here that Charpy impact testing is not sufficient and is not depositive and cannot be relied upon by licensees or the NRC to determine the degree of

neutron damage (embrittlement) to a PRV due to neutron fluence. Moreover, as referenced in the 2.206 petition(s), plant-specific loading (i.e. reactor trips) directly challenge the integrity of the PRV, and should be considered by licensees in assessing the degree of PRV embrittlement, especially when licensees engage in the NRC reactor capsule surveillance data sharing program. This is true because every time that a nuclear reactor trips off-line, a Pressurized Thermal Shock (PTS) event occurs where safety injection pumps introduce cool water directly into the extremely hot reactor vessel. During the PTS event, the integrity of the RV is challenged. Each time that the integrity of the RV is challenged by a PTS event, the RV material contracts due to the introduction of the cool water. Thus, the integrity of a RV may fail during a PTS event depending on how embrittled the RV has become due to neutron fluence during extended power operations. As stated earlier, both licensee nuclear engineers and NRC nuclear engineers originally believed that the integrity of a RV could only be maintained over the RV's original 40-year safety design basis. Thus, the NRC and its licensees are engaged in an experiment - at the expense of public health and safety - to see just how long the integrity of a RV can be maintained during expended power operations up to 80-years.

Petitioners further contend that the test capsule data provided to the NRC by licensees who are part of the reactor vessel surveillance program where capsule Charpy test data taken from one nuclear reactor vessel is submitted to the NRC as representative of the amount of neutron damage to the RV of another RV is not sufficient to accurately determine the amount of neutron damage (embrittlement) of the latter RV.

First, there is no single test location authorized by the NRC or utilized by licensees where Charpy impact testing is performed. Therefore, the testing performed by one vendor can widely vary in accuracy from another vendor depending on the testing facility's equipment, testing procedures, qualifications of employees conducting the tests, human interpretation of the test results, gravity affects on the testing machine, the vintage of the testing machine, the placement of the test specimen in the testing machine, the machining of the v-notch in the test specimen, etc.

Second, as stated earlier, Charpy testing should only be used for comparative analysis and cannot be relied upon by licensees to represent the degree of embrittlement of their respective RVs. This is true regardless of the tolerances allowed in NRC Regulatory Guide 1.99, Revision 2, May 1988. To the extent that licensees submit Charpy tests results to the NRC for test results of capsule test samples taken from another RV and not their plant specific RV, the data submitted to the NRC is further erroneous and not representative of the degree of embrittlement of the licensee's plant specific RV. This is true because the placement of the test capsule inside the RV (the distance that the capsule is placed from the RV wall, the height of placement, the operational history of the RV, the exact properties of the RV material, etc. results in different neutron fluence data obtained from one RV to another.

Third, NRC Regulatory Guide 1.99, Revision 2, May 1988, states in part that:

> ". . . The calculative procedures given in Regulatory Position 1.1 of this guide are not the same as those given in the Pressurized Thermal Shock rule (§50.61, "Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events," of 10 CFR Part 50) for calculating RT_{PTS}, the reference

> temperature that is to be compared to the screening criterion given in the rule. The information on which this Revision 2 is based may also affect the basis for the PTS rule. The staff is presently considering whether to propose a change to §50.61.

Petitioners contend that licensees who are operating PRVs (nuclear reactors) in extended power operations beyond the PRV's original 40-year safety design basis and who justified in their respective license amendment request(s) for extended power operations, by referencing, and relying on, and using the NRC Regulatory Guide 1.99, Revision 2, May 1988, are conducting licensed operations of nuclear reactors in violation of NRC regulations and requirements in 10 C.F.R. 50 and 50.61. This is true because NRC Regulatory Guide 1.99, Revision 2, May 1988, contains information on which Revision 2 is based that may also affect the basis for the PTS rule. Therefore, PRVs that are operating in extended power operations may experience a PTS event that causes the RV to crack. Such an event would result in a nuclear LOCA causing the affected licensee to declare a General Emergency nuclear accident. To the extent that licensees are only required to evacuate a 10-mile area around the nuclear facility, the LOCA would kill thousands of people. Furthermore, such a nuclear accident would result in a complete core melt-down and a resultant explosion destroying the containment building due to a build up of of hydrogen released into the containment building. The plume of radioactive particles released into the environment would travel with the prevailing winds and would permanently containment areas, for example, Washington, DC causing the permanent evacuation of people in the nation's capitol.

Petitioners contend that extended power operations of existing PRVs represents an unwarranted risk to the National Security and Common Defense of the United States and to the health and safety of the public and that the NRC should issue a Confirmatory Order requiring the immediate shut down of all PRVs currently operating in extended power operations.

Fourth, for the reasons stated above, Charpy testing is not sufficient to justify extended power operations for 60-years or 80-years or 100-years to ascertain the degree of embrittlement of each licensee's plant-specific RV as required in NRC Regulatory Guide 1.99, Revision 2, May 1988, and that Revision 2, cannot be relied upon by licensees to justify extended power operations of PRVs for the reasons previously stated above.

Fifth, NRC Regulatory Guide 1.99, Revision 2, May 1988, at 2. SURVEILLANCE DATA AVAILABLE, states in part that:

> "When two or more credible surveillance data sets (as defined in the Discussion) become available from the reactor in question, they may be used to determine the adjusted reference temperature and the Charpy upper-shelf energy of the beltline materials as described in Regulatory Position 2.1 and 2.2, respectively."

Thus, Petitioners aver here that the NRC Regulatory Guide 1.99, Revision 2, May 1988, requires NRC licensees to submit Charpy test data from PRV capsule samples taken from their plant-specific PRVs and that the licensees are not authorized to submit Charpy test

data derived from another PRV employed in the NRC participant reactor vessel surveillance program.

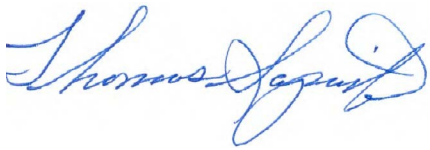
Sixth, Regulatory Guide 1.99 Revision 2, May 1988, "Radiation Embrittlement of Reactor Vessel Materials," provides for the use of two substantially different methods for determining through-wall fluence in nuclear reactor pressure vessels. One method is a generic attenuation curve based on a simplistic exponential decay equation. Partly due to the simplicity of its application, the generic attenuation method is predominantly used for licensing calculations. However, it has a limitation in that at increasing distances away from the core beltline, it becomes increasingly less accurate because it cannot account for neutron streaming effects in the cavity region surrounding the pressure vessel. The other attenuation method is based on a displacement per atom (dpa) calculation specific to the reactor vessel structure. The dpa method provides a more accurate representation of fluence attenuation through the reactor pressure vessel (RPV) wall at all elevations of the pressure vessel because it does account for neutron streaming in the cavity region. A requirement for using the dpa method, however, is an accurate flux solution through the RPV wall. This requirement has limited the use of traditional transport methods, such as discrete ordinates, that are limited by their treatment of cavity regions (i.e., air) outside the pressure vessel wall. TransWare Enterprises, under the sponsorship of EPRI and BWRVIP, has developed an advanced three-dimensional transport methodology capable of producing fully converged flux solutions throughout the entire reactor system, including in the cavity region and primary shield structures. This methodology provides an accurate and reliable determination of through-wall fluence in boiling water reactor (BWR) and pressurized water reactor (PWR) pressure vessels, thus allowing the dpa method to be implemented with high reliability. Using this advanced 3-D methodology, this paper presents comparisons of the generic and dpa attenuation methods at critical locations in both BWR and PWR pressure vessel walls. See, Comparison of Regulatory Guide 1.99 Fluence Attenuation Methods, April 2012 Journal of ASTM International 9(4):104028.

Thus, Petitions aver here that the NRC should require its licensees to use the above described dpa method to more accurately represent the fluence attenuation through the reactor pressure vessel wall at all elevations of the pressurized vessel because it accounts for neutron streaming in the cavity region and therefore provides more accurate and more meaningful data to the NRC about the degree of RV embrittlement due to the damage sustained from neutron fluence.

Conclusion

For all the above stated reasons, the NRC should take the requested enforcement action against its licensees as requested above and as requested in the earlier 2.206 petitions to protect the health and safety of the public and to protect the environment. Petitioners once again urge the NRC to issue a Confirmatory Order to all PRV licensees requiring the immediate shut down of all pressurized nuclear reactors which are currently operating in extended power operations in the United States of America.

For the Petitioners



Thomas Saporito
Executive Director

* A copy of this electronic communication is being provided to the NRC Office of the Inspector General to enable that agency to monitor the actions of the NRC in this important matter to protect the health and safety of the public and to protect the environment from the catastrophic effects of a serious nuclear accident originating from a licensed commercial nuclear power plant regulated by the NRC.